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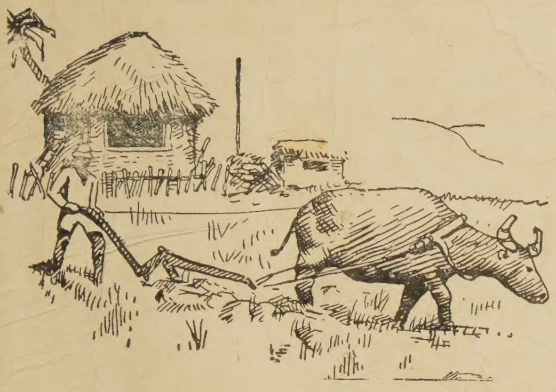

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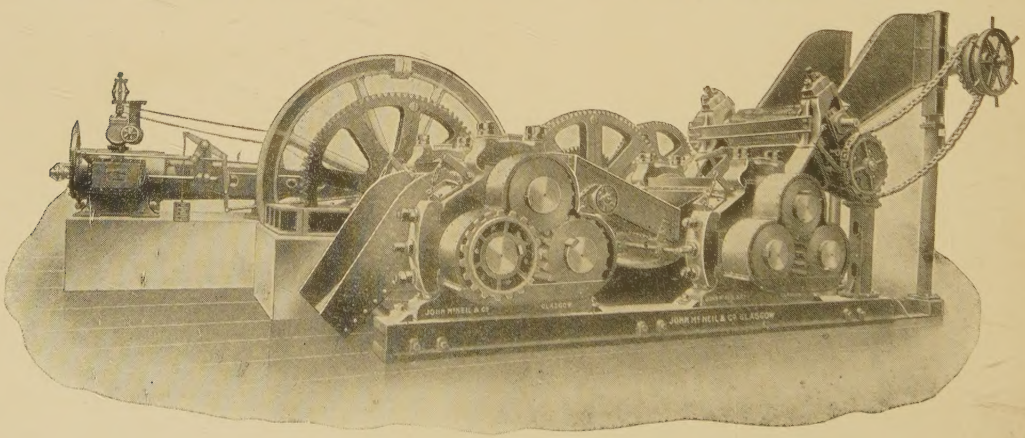

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THE PHILIPPINE AGRICULTURIST AND FORESTER

Vol. I. **JULY, 1911** **No. 5**

FACULTY CHANGES

Mr. and Mrs. E. M. Ledyard left at the end of the college year in March to spend a year in travel and study. When last heard they were in London. They have been members of the faculty of the college since its establishment and have had a very active part in its development.

Dr. F. W. Foxworthy, until recently one of the botanical staff of the Bureau of Science, has transferred to the Bureau of Forestry and is established as a member of the college faculty. Dr. Foxworthy is well known by his studies of the woods of this part of the world, and his chief work here will be wood technology. During this year he also has charge of entomology, in which subject he took his master's degree at Cornell.

Associate professors H. N. Whitford and H. M. Curran have returned from leave spent in the United States, both visiting India and Europe en route. Dr. Whitford made a brief official inspection of forest conditions in the Malay States and India.

Mr. R. F. Nash, who was the entire resident faculty of the forestry course during a part of last year, has resigned and returned to America. Mr. D. M. Mathews, a master of forestry from the University of Michigan, becomes secretary of this course, but the increase in work has made it necessary to add Mr. Curran and Drs. Whitford and Foxworthy to the resident staff. Major Ahern and Mr. Schneider are non-resident members of this faculty.

Doctor Horris G. Deming, who completed his work at the University of Wisconsin last Spring, has arrived at Los Baños, and taken up the work of Chemistry. The work of the first two years is definitely organized, the first year class having forty students, and the second year sixteen. Besides this, there are a few students taking more advanced work, and lecture course is being given in Agricultural Chemistry. The laboratory is well filled and will be badly overcrowded before it is possible to increase the room available for this work.

The work in Languages, which has, hitherto been given by Mrs. Ledyard, is now in the hands of Mr. Artemas L. Day. Mr. Day is a graduate of the University of Chicago, and has also studied at Harvard and the University of Pennsylvania. He spent one year in the study of Marine Zoology on the "Albatross".

Mr. Inocencio Elayda, a graduate of the Iowa State College, has been added to the College staff as assistant in Algebra and Geometry.

The first Commencement of the University was held in Manila March 31st. From the College of Agriculture, Mr. Manuel Roxas received the degree of Bachelor of Science, Mr. Clodoaldo Tempongko and Mr. José Zamora the degree of Bachelor of Agriculture. There were also three graduates from the College of Medicine, and four from the College of Liberal Arts. The Commencement address was delivered by His Excellency, the Governor-General. Mr. Zamora is now in charge of his father's hacienda in Tarlac, Mr. Tempongko is working in Mr. Pedro Roxas's hacienda in Kalawang and Mr. Roxas is an Assistant in this College.

Control of Diseases and Pests by Cultural Methods

By Felipe O. Cevallos

Modern farmers in Western Europe and in some parts of the world where agriculture is highly developed have a number of ways of keeping diseases and pests in check; one of the ways of fighting them is by *Cultural Methods*. *Cultural Methods* mean the methods of cultivation which will prevent the coming of diseases and pests; they also mean the ways of eradication of the enemies already established on the plantations.

Farm crops are for the most part subject to the frequent attack of diseases and pests. Certain plants are susceptible to the attack of specific diseases and pests, while others are liable to be injured by almost any kind. The number of these enemies increases with the number of various crops raised on the farm, for they then find conditions favorable for their best development and rapid multiplication. A prospective farmer must take the best of care to prevent the coming of diseases and pests into his plantation, and if any of them happen to visit it, he must not cease his efforts to eradicate them until his crops are perfectly safe from the attack.

As a rule, plants which are healthy and vigorous because supplied with the proper amount of food are less susceptible to diseases than those which are weak and ill-nourished. So field crops must absolutely have the proper amount of food-materials in order to be free from damage by certain piseases.

There is no better way of checking enemies, both diseases and insect pests, about the farm than to get rid of them at once and absolutely before they have taken possession everywhere around the place; if, for example, they have already taken possession of the field, it is a difficult task to drive them away, especially when favorable conditions are present for their best development, and in many cases the attempt to stop their attack will amount to a large sum of money and a loss of time.

Most of us know that the coffee industry in Lipa was wiped out on account of the attack of the coffee-rust. This disease did a great deal of damage to the coffee planters in Lipa to the extent of millions of pesos. Proper cultural methods would have reduced the loss and saved this industry.

A few years ago bud rot occurred in some parts of the coconut-growing districts in Laguna; for example in the towns of Lilio, Nagcarlang, etc., I was informed by some of the coconut planters that this disease was found to attack the trunks and leaves of the coconut. They further stated that attacked trees could hardly recover and in a very few cases trees which recovered did not bear fruits for a long time. Owing to their exact knowledge of how to detect this disease at once and to their immediate attention to stop it they eradicated it absolutely within a short period, or in other words they checked it at once before it could take possession of the whole coconut plantations. The people of Laguna Province enacted laws for the control of such diseases and in effect these laws gave good results. The coconut growers, hacenderos or landowners have put their plantations in absolute cleanliness, every attacked tree was cut and burnt, they sprayed the infested trees, etc.

The writer has had some data obtained from a careful observation on some insect-pests that did considerable damage to a number of valuable crops raised on the College Farm. Before the College Farm was put into good cultivation, there were large numbers of injurious insects and some of them were found to damage corn,

rice, coconut, and other important crops grown by the native people who owned the land. At present, these pests are being gradually reduced in number and in kinds for we fight them by Cultural Methods. *Rhyncophorus ferrugineus* (*curculionidae*) and the *Oryctes rhinoceros* (*Dynastidae*) are the two most common and worst enemies of the coconut, In one of the coconut groves which was in bad condition at the time of its purchase by the College, the number of these insects has been very much decreased by destroying dead and badly infested trees and keeping the grove clean. Their breeding places were destroyed; infested trees were cut and burnt and the plantation is put into a cleanly condition.

Every body who lives in the coconut growing district knows that these two kinds of insects are the worst enemies of the coconut. They generally attack the soft part of the tree, so that there is no hope that a plant will continue to live after it has been injured in that special part. These pests were to breed in decayed vegetable and animal matter and the Oryctes is always found to breed in both kinds of matter, but the other is very seldom found in them; it lays its eggs in the soft part of the plant.

It was also observed by the writer that the presence of hedge-rows about the farm promotes the coming of the insect pests which use them as their breeding places. For instance the insect (*Lipto corisa acuta*) was found to attack the rice grown at the College Farm. This insect breeds along hedge-rows very favorably, in the grasses (*Rattboellia exaltata* and *Banicum auritum*) which bear fruits with milky juice. The rice field was surrounded by hedge-rows and the insect migrated to the rice field just before the fruits ripened. It sucked the milky juice of the fruits and consequently it did considerable injury to the crop. Every crop of rice raised in this spot was always damaged by the same insect until the complete destruction of the hedge-rows. This method of destroying hedge-rows is not only observed at the College Farm but it is also practiced by some farmers in Los Baños. Such practice gives good results.

Another evidence of the good effect of destroying hedge-rows was in the case of corn raised also on the College Farm. Four succeeding crops of maize grown in a piece of ground surrounded by hedge-rows were always infested by the insect (*Pyrausta nastatrix, Schultze*) (corn moth borer), but the fifth crop was not attacked, owing to the fact that the hedge-rows were destroyed before it was planted. These hedge-rows were grasses which belong to the same family as corn.

Rotation of crops does not only help to get rid of weeds that are common among cultivated plants, to add vegetable matter, and to add nitrogen to the soil, but it also does do great help to avoid the attack of diseases and pests upon certain field crops. It has been observed at the College of Agriculture that rotation of crops has had a great influence in checking the attack of certain insect-pests. From my own observation here, I have found that insects which infest corn, rice, camote, etc., could be held in check by not planting these plants during the breeding season of these pests, and in that way their young will not have food to feed upon.

It was also found in Mexico that the practice of growing cotton every other year saves the crop from the infestation of the insect which attacks it generally. Rotation of crops must be conducted in a scientific and practical way in order to have profitable results. It is not worth while to go to work if the prevailing conditions are unfavorable to the best development of the plants. The circumstances of course must be determined by the farmer.

Lands, which are lying idle all the year round, serve as good breeding places of certain insects. Take, for instance, the case of locust; this insect breeds in grounds that are not cultivated. Some of these uncultivated grounds are adjacent to cultivated fields, so it is very probable that this pest may visit the cultivated farms and destroy the crops. In order to prevent the attack and to check it from breeding in such places it is necessary to bring these grounds into good cultivation or to allow them to revert to forest. This practice will not only be of benefit to the particular region but to other regions having the same crops.

Every farmer must always bear in mind that his crops must be absolutely free from the injury of these enemies in order to have the most profitable returns. And the crops can be made more or less perfectly safe from the attack of these common enemies by carefully observing the following important practice:

1. The destruction, for the most part by fire, of diseased trees, plants or portions of the plants; in this way the spores of fungi carry the infection of the diseases and destroyed; the breeding places of insects are checked. There is an old saying that "a stitch in time saves nine," that is to say, it is much easier to prevent diseases than to cure them.

2. To determine special attention as to the cost, best method of use and effects of insecticides and fungicides.

3. Isolation of the diseased plants.

   a. by digging trenches to prevent infection from spreading to the healthy plants.

   b. Quarantine must be practiced, that is, the prohibition of the removal of the plants, seeds or part of the plants from districts already infected by disease into places where it does not occur.

   c. To isolate the given areas of the cultivated crops by planting "shelter belts" of trees through them. These methods have been practiced in parts of the world where Agriculture is highly developed, especially in Western Europe, in the United States and in some parts of the Tropics. I do not have any doubt at all that these methods will be effective in the Philippines since they give favorable results in other parts of the Tropics which more or less have the same conditions.

There are probabilities that in localities where coffee is grown, the use of dried tea leaves in infusion as a beverage will be supplanted by dried coffee-leaves. An infusion of the latter produces an aromatic beverage somewhat bitter to the taste, and which contains practically as much theine as a real tea, while having the advantage of containing less proportion of tannin, which is not a desirable component in a beverage.

The refreshing and restorative effect of an infusion of dried coffee leaves was already known to the old coffee planters of Lipa. Some of them even claim that it is better than real tea.

The importance of this fact to the coffee planters is obvious. If the use of coffee in this way be generalized this plant will be doubly valuable.

There have recently been several changes in the membership of the Board of Regents. The new members are the Honorable, the Secretary of the Interior, who is acting Chairman in the absence of the Secretary of Public Instruction, Justice E. Finley Johnson of the Supreme Court, and Attorney-General Villamor. Doctor Pardo de Tavera has been obliged by ill health to resign from the Board. He had a keen and active interest in the work of the University, and his loss is seriously felt.

Mr. Mauricio Oteyza, a master of forestry from Yale Forest School, has been made assistant in Forest Engineering and Forest Management in this College.

The Effect of Some Stimulants Upon Rice

MANUEL ROXAS.

I.

The use of stimulants on agricultural crops is a problem the solution of which promises to be of interest to scientific farmers. The practical application of stimulants in farm practice is shown by the discovery of Frank and Krueger that "by proper application of copper, a potato plant can be stimulated to the production of sturdier leaves and more chlorophyll, and to more active transpiration and assimilation and longer life." This discovery makes it more desirable to use Bordeaux mixture for spraying a potato field than any preparation in which no copper (or some other stimulant as strong and cheap as copper) is used. Indeed, where spraying with copper is practiced a very sensible increase in the yield can be noticed.

The literature cited in this paper on the general subject of stimulants up to 1899 is summarized from "The Influence of the Presence of Pure Metals upon Plants," by E. B. Copeland and Louis Kahlenberg, published during that year. What little work has been done since on the same subject is also given as far as it is available.

There is an extensive literature on the toxicity of the salts of the different metals. Knop and Peligot consider boric acid poisonous. But Paul and Kroenig say it is not very injurious. Copeland and Kahlenberg found the presence of metallic boron to affect the growth of the primary root of *Lupinus albus* and *Avena sativa* in water culture; as the compound of this element begin to enter into solution, its first action on the plant was that of a stimulant, but when the same compound becomes more concentrated, it becomes distinctly toxic. Traces of boron have been found in the ash of many plants.

Manganese has been detected in the ash of a great number of plants, but in great concentration it is injurious, as demonstrated in the experiment of Molisch. The Hawaii Agricultural Experiment Station, studying the effect of the so-called black soils of Hawaii on the growth of pineapples, has found a close correlation between the degree of wilting of the pineapples and the percentage of manganese in the soil. By the hydrochloric acid test, it was proven that manganese is present in these black soils largely in the form of the higher oxides. The injury seems to be due to the oxidation of the chlorophyll brought about by the greater activity of the oxidase of the leaves. Bertrand found that the ash of the oxidizing enzymes contains considerable amounts of manganese, and that the addition of soluble manganese salts to the oxidase greatly accelerated their oxygen-carrying power. Manganese in small amounts exercises a stimulating action. K. Aso, from work with $MnSO_4$, concludes that manganese is injurious in large quantity; that a dilution of 0.002 per cent of $MnSO_4$, added to culture solutions stimulates the growth of radish, barley, wheat, and pea; that iron seems to counteract to a certain degree the action of manganese; and that the oxidizing enzymes of plants treated with manganese are better developed than those not so treated. Spampani holds that manganese, while not a substitute for iron, will postpone chlorosis. Copeland and Kahlenberg found the presence of metallic Mn in lumps in water culture to be deleterious, but not fatal to the growth of *Lupinus albus* and *Avena sativa*.

Lupines, according to Kahlenberg and True, will just live in N|12,800 $HgCl_2$; but the limit of endurance for *Pisum sativum*, as found by Heald, is N|204,800. Ono found that an acceleration of growth took place in fungi after the addition of a minute quantity of $HgCl_2$. The salts of

mercury were found among the most poisonous by Paul and Kroenig for bacteria, and by Stevens for fungi. The presence of this metal in water culture was found by Kahlenberg and Copeland to kill *Soja hispida*, and to be very injurious to *Zea Mays*, *Lupinus albus*, and *Avena sativa*.

Iron in traces is known to be essential to plant life, but in large quantities it may prove stimulating and poisonous. Richards finds $FeSO_4$ in appropriate dilution to act as a stimulant upon *Aspergillus*. N|51,200 is stated by Kahlenberg and True to be the concentration at which Fe ions are fatal. According to Copeland and Kahlenberg, ferrous salts may be injurious chiefly by their reducing action, and the influence of iron upon plants depends, in general, upon whether it is present as a colloid or as a crystalloid substance. According to these same authors the presence of metallic iron in water culture is very injurious to *Zea Mays*, *Lupinus albus*, *Avena sativa*, and *Soja hispida*.

It is universally recognized that the salts of copper are extremely poisonous. Molisch finds $NiSO_4$, $CoSO_4$, $ZnSO_4$, and $CuSO_4$, poisonous. Günther holds that copper acts upon fungi as a stimulant when very dilute, and as a poison, when not so dilute. Ono confirms Günther's statement. N|25,500 solution of either copper, nickel, or cobalt salts is enough to kill *Lupinus* in twenty-four hours, according to Kahlenberg and True. Hattori puts the extreme limit of concentration of copper salts at 0.00005 *per cent* for the pea, and at 0.000005 *per cent* for the maize. Phillips, quoting Freytag, states that the toxic power of nickel is about three-fifths of that of cobalt. But Heald and Richards make the difference greater, Heald giving N|6,400 $CoSO_4$, and N|51,200 $NiSO_4$, as the solutions just permitting the growth of *Zea Mays*, and Richards, 0.002 *per cent* $CoSO_4$, and 0.033 *per cent* $NiSO_4$, as the optmium concentration for *Aspergillus niger*. Copeland and Kahlenberg's results agree with those of Richards in the sense that cobalt is decidedly more poisonous than nickel. Copeland found that *Elodea* is killed in twenty four hours by M|100 solution of $NiCl_2$, and somewhat injured by M|200; that the same plant dies after twenty four hours in a solution of M|10,000 $CoCl_2$, or after twenty-five hours in M|20,000 $CuSO_4$, but that it can live in M|40,000 $CuSO_4$.

Zinc is known to be both a poison and a stimulant. Knop, attempting to substitute it for calcium, found it poisonous, and Nobbe, Baesler and Will, state that it is more so than lead, but less so than arsenic as arsenite. Krauch finds it injurious in minute quantity in water culture, but less so in the ground. At a sufficient dilution it acts as a stimulant. Raulin demonstrates that 0.0005 *per cent* of $ZnSO_4$, added to a nutrient solution, favors the growth of fungi, and that if this amount is increased to 0.0030 *per cent*, the weight of the plant is doubled. Copeland and Kahlenberg state that the presence of elementary zinc in the water where their plants grew was always fatal. Copeland, from work with *Elodea* in 1903, concludes that M|100 $ZnSO_4$ kills this plant in three hours, M|200 injures it in twenty-six hours, but M|500 allows it to be sound indefinitely; the temperature at the time of his experiment was below 20°C.

Aluminium was not found very poisonous by Copeland and Kahlenberg, and their conclusion is confirmed by Molisch in his experiment with *Hortensia*, where he applied great quantities of $Al_2(SO_4)_3$. Molisch also found that alum is entirely harmless. Aluminium constitutes from twenty-two to thirty-nine *per cent* of the ash of *Lycopodium Chamaecyparissus*, *L. complanatum*, and *L. clavatum*. It is also an occasional constituent of many flowering plants, as of *Hydrastis*, where Al_2O_3 makes up 0.3259 *per cent* of the dry weight

of the roots according to Gaze. Jamano found aluminium of service to the development of barley.

The following account of S. Suzuki and K. Aso's results with iodine and fluorine compounds on agricultural plants is given in full, because the work described in this paper is in line with the experiment of these authors. Suzuki, working on soil cultures, found that 2.6 grams of KI in 10,000 kilograms of soil can yet exert stimulating action on oats; but he also found that when seeds of oats are soaked in a one *per cent* solution of KI for twenty four hours, a retarding influence is noticed in the plants growing from the seeds. In a field experiment with oats, the same author found that 0.25 gram of KI applied over twenty square meters produced a small increase in the yield. From his results with this same chemical on radish, he gives the following outlay with the profit to be derived:

KI applied for 20 sq. m..	0.05 g.
KI corresponding to 1 ha.	25.00 "
Its cost.....	0.60 yen.
The increase in harvest per 20 sq. m.....	2.17 Kg. root.
The increase corresponding to 1 ha.....	1085.00 "
Its value.....	28.90 yen.

According to Suzuki the favorable action of sea weeds when used as green manure on crops, a practice commonly followed along the coast of Japan, "is not only due to the small amount of potassa, nitrogen, and phosphoric acid, but also to some extent to the small amount of iodine present."

Aso found that a 0.05 *per cent* solution of NaF is still injurious to seeds of rice, wheat, mustard, and soy-beans, those of rice being the least affected. Working with water cultures he found that the addition of a 0.005 *per cent* solution of NaF proved poisonous to soy-beans, but stimulated barley to the production of a greater number of stalks; that a 0.001 *per cent* solution was poisonous to the pea and wheat, but a better concentration for barley, and a stimulant for rice, increasing the number of flower buds, but decreasing the size of the flowers; that a 0.0001 *per cent* solution has no effect on pea and wheat, but still stimulates rice. Aso also found that 0.00261 gram of NaF added to one kilogram of air dried soil produces a stimulating action on pea. From his work with the same salt on radish, he gives the following results:

NaF applied for 10 sq. m...	0.14 g.
NaF corresponding to 1 ha.	140.00 "
Its cost.....	0.084 yen.
Increase of harvest per 10 sq. m.....	4.156 Kg.
Increase corresponding to 1 ha.....	4156.000 "
Its value.....	110.60 yen.

The same author found that a 0.005 *per cent* solution of sodium silicofluoride kills barley and soy-bean shoots almost completely in six days, and that 0.001 *per cent* kills soy-beans in fifteen days, but increases the number of stalks of barley, although reducing its growth in height. CaF being faintly soluble in water, only about 1:26,000, has a milder effect upon plants. Aso found that 0.0025 gram of CaF per kilo of soil stimulates the growth of *Helichrysum bracteatum*. He also found a probable stimulating action on pea of a 0.1 *per cent* of CaF added to a nutrient solution, but in soil culture, 0.2 gram added per 1.5 kilogram of soil increases the production of fruit of the same plant. A 0.01 per cent solution in water culture stimulates the growth of barley.

Other elements the salts of which are known to be both stimulants and poisons are not given in detail here. Copeland and Kahlenberg state that the well known fact in animal physiology that the phenomena of stimulation and of poisoning are very intimately related, is applicable in

plant toxicology. Copeland in 1903, from work on "Chemical stimulation and the evolution of carbon dioxide," concludes that "no poison has been found *not* to act as a stimulant." This statement includes some of the well known organic poisons.

Summarizing the effect of the several elements upon plants, it appears that the salts of gold, silver, platinum, mercury, palladium, and tungstens, are extremely poisonous; those of copper, nickel, cobalt, boron, zink cadmium, thallium, arsenic, iodine, and fluorine, very injurious; and those of bismuth, magnesium (under certain conditions), sulphur (sulphides and sulphites, generally), manganese, chromium, yttrium, and selenium more or less so. The majority of these substances positively, and all of them presumably, are both poisons and stimulants.

Of the organic substances, chinin, antipyrin, oxalic acid, cocaine, morphine, amygdaline, KCN, strychnine, and ether have been found by different investigators to act as stimulants.

While there are many substances known to accelerate the growth of plants, yet quantitative data are lacking as to the best concentration to apply on individual crops, and investigation along that line is urgently needed.

II.

I performed this experiment in order to determine the approximate optimum concentration of several stimulants for rice. The experiment was started on February 18. Forty five earthen pots each holding 900 grams of soil, were cleaned and dried, and the outside soaked with coconut oil to make it impermeable to water, thus preventing evaporation from the sides. About three cubic feet of ordinary loam was mixed with one-half as much sand, and the mixture shoveled up into a uniform mass. Exactly 900 grams of this mixture was put into each pot. Seeds of rice of an upland variety were germinated between two pieces of moistened filter paper, and on February twenty-second, when their plumules and radicles were just coming out, the seedlings were planted two in each pot. Two days later the weaker of these was taken out. These pots were divided into lots A, B, and C; A and B contained twenty pots each, and C, five. Each plant in lot A received 16.8 c. c. of a molar solution of NH_4NO_3, 3.3 c. c. of a molar solution of K_2HPO_4, and 2.6 c. c. of a half-molar solution of $CaH_4(PO_4)_2$. These substances were applied by means of a burette reading to two-tenths of a cubic centimeter, the amount required of each solution being first diluted to 100 c. c. before pouring into the pot. Each plant in lot B received the same amount of NH_4NO_3 and K_2HPO_4 as those of lot A, but were given no $CaH_4(PO_4)_2$. These amounts are calculated on the assumption that there are 160,000 plants to the hectare, and on the application of 214.4 Kg. NH_4NO_3, 92.5 Kg. K_2HPO_4, and 46.24 Kg. $CaH_4(PO_4)_2$ per hectare. By dividing each of these latter amounts by 160,000, the quotients are the quantities that correspond to each plant: 1.34 gms. NH_4NO_3, 0.578 gms. K_2HPO_4, and 0.289 gms. $CaH_4(PO_4)_2$. Plants of lot C received no fertilizers. Each pot was given 150 c.c. of water daily in two waterings: 100 c. c. in the morning and 50 c. c. at about five o'clock in the evening. This quantity is enough to keep the pots moist, but not so wet as to drain at all from the bottom. For lack of a better place the pots were kept on the eastern veranda of the temporary building of the college, where they could receive sunlight in the morning; but because the plants were soon showing signs of too much shade, the pots were put on boards and exposed to full sunshine every morning and brought back in the evening and before rain. Then also because the evaporation from the pots was

greater the amount of water given daily was increased to 200 c. c. served in three waterings; 100 c. c. in the morning, 50 c. c. at noon, and 50 c. c. in the evening.

Daily measurements of the growth of all the growing leaves were taken.

On March eleventh the stimulants were applied. One *per cent* solutions of $Na_2Bo_4O_7$, $MnSO_4$, $HgCl_2$, $FeSO_4$, $FeCl_3$ $CuSO_4$, $Cu(NO_3)_2$, $NiSO_4$, and $ZnSO_4$ were prepared by weighing accurately four grams of the previously desiccated salts; these were dissolved in distilled water and the solution diluted to 400 c. c. On account of the large amount, in which $Al_2(SO_4)_3$ was administered, a 70% solution of this salt was prepared. The amount of the different stimulants given to each plant is expressed in fractions of a molar solution as shown at the heads of the vertical columns of the table. It was expected that pots 1 and 15 in Mr. José Zamora's experiment on fertilizers, started at the same time as this one, should serve as controls for pots B and A respectively, but on April third his pots were taken from the College and placed under such conditions as to make comparison impossible. To remedy to some extent this lack of control, two pots of lot C were fertilized as in A, and another two as in B.

The table given below shows the growth of the most rapidly growing leaf of each plant at two-day intervals. It comprehends the period between the time of application of the stimulants and the time of maturing of the fruits. The numbers in italics mark the date of appearance of the youngest leaves, which are then the ones growing most rapidly. The frequency with which these leaves appear may also be a gauge of the thrift of the plant. Usually a leaf grows slowly at first, and then gradually faster up to a certain point when the growth goes down again until it stops. But sometimes the growth is rapid at the start, and then continuously slower to the point where it stops. Again, there are leaves which have two periods of rapid growth. The numbers in parenthesis in the top line show the number of leaves developed by each plant up to March 13. All the plants, with the exception of A-2, A-1, B-8, and B-2, were in fruit when the experiment closed. The last numbers of each column, that is, those below the lowest italicized number, show the growth of the head. The last four columns are the plants of lot C fertilized April 10. The average for the growth, from this date, of each plant is indicated in the last horizontal column. The growth up to April 2 of plants 1 and 15 of Mr. Zamora shows a higher average than that of the majority of the plants in lots B and A respectively. This is accounted for by the fact that his plants received less illumination, which resulted in a more rapid growth at the start. Partly for this reason and partly because they acted as controls of my plants only for so short a time as not to furnish a very safe average, 1 and 15 are omitted from the table.

The behaviour of each plant can not altogether be construed as the effect of the poison, for it is evident that the peculiarities of each individual play a great par tin it.

Plant A-2 was decidedly injured by a M|100 solution of borax. Two days after the application of the solution, the leaves of the plant were all withered except the youngest, which continued to grow. Injured as the plant was, it still lived up to the time of flowering. M|1000 was also injurious, as evidenced by the dying of the tips of the leaves two days after the application, and by the arrested growth. M|10,000 shows at the start a decided stimulating influence. This was only for a relatively short time, since it afterwards showed signs of injury at the tips. That the plant was later affected by the poison is indicated, further, in the averages. The reverse is the case with M|100,000. While its average from

T

Growth of the most rapidly

Date.		$Na_2 Bo_4 O_7$					$Mn SO_4$			* $Hg Cl_2$				$Fe SO_4$				$Fe Cl_3$	
		A–2	A–3	A–4	A–5	A–6	A–7	A–9	A–10	A–11	A–12	A–13	A–14	A–16	A–18	A–19	A–20	A–1	A–15
		M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M
		100	1000	10000	100000	1000000	1000	10000	0000	50.000	100000	500000	1000000	1000	10000	50000	1000	5000	10000
March	13	29[4]	62[4]	86[5]	44[4]	50[4]	38[4]	16[3]	36[4]	*23*	84[5]	54[4]	66[4]	52[4]	*37*[4]	43[4]	43[4]	..	40[4]
"	15	*4*	*51*	89	*37*	*38*	35	*7*	34	110	70	73	46	*50*	82	39	*26*	34[3]	52
"	17	23	80	*71*	61	70	*22*	48	*28*	*25*	*56*	*41*	*33*	74	73	*20*	73	*27*	*29*
"	19	19	78	128	81	80	69	*45*	73	94	122	81	101	89	*55*	80	67	68	80
"	21	15	*50*	*75*	*36*	*46*	*50*	68	61	67	71	65	61	*48*	85	49	*26*	52	*47*
"	23	13	79	*73*	97	104	80	74	*57*	*51*	*70*	*50*	*46*	106	79	*29*	90	*33*	96
"	25	14	58	82	67	75	*66*	*46*	67	85	85	80	73	74	*62*	75	62	63	70
"	27	20	50	121	*71*	*90*	74	92	99	99	124	112	121	89	127	86	*60*	74	*79*
"	29	15	*40*	70	99	114	*19*	77	52	56	54	52	24	*96*	80	*26*	101	35	100
"	31	6	90	47	78	94	75	68	96	30	24	30	22	102	70	92	84	16	91
April	2	*5*	70	*24*	51	68	72	*42*	*20*	*18*	*12*	*17*	*12*	76	47	76	*55*	*9*	70
"	4	31	55	85	*38*	*54*	*65*	72	67	80	58	64	63	*50*	*23*	*56*	77	52	*46*
"	6	28	52	72	79	77	75	65	59	*54*	54	*56*	*56*	87	77	80	87	*30*	84
"	8	20	*30*	55	64	73	66	43	*29*	83	30	65	56	90	69	73	62	60	66
"	10	*18*	55	*56*	70	80	76	52	92	106	*25*	93	85	83	73	88	64	78	73
"	12	46	64	60	*57*	77	*74*	*25*	94	104	74	99	97	*72*	*49*	*78*	*37*	74	*67*
"	14	41	67	80	96	*34*	102	84	51	*42*	57	51	52	123	82	106	82	19	92
"	16	40	66	76	94	99	102	70	50	106	54	46	48	118	80	102	82	16	90
"	18	40	66	76	94	98	102	70	50	106	54	46	48	118	80	102	82	16	90
"	20	*29*	*47*	68	81	88	79	*51*	*27*	104	79	*27*	*28*	89	69	83	62	*8*	73
"	22	37	40	29	26	50	19	57	54	50	*9*	55	51	*25*	31	32	*23*	*39*	30
"	24	38	27	17	*16*	22	20	38	34	32	24	36	40	44	18	*16*	26	66	14
"	26	64	102	*42*	97	79	*42*	83	75	*74*	89	74	85	101	*34*	79	59	89	*29*
"	28	59	112	80	94	*61*	103	86	*45*	124	92	*53*	*57*	89	56	85	63	96	47
"	30	43	54	61	84	84	85	45	63	87	44	47	49	*63*	49	71	55	68	51
May	2	33	30	34	58	57	48	30	60	56	26	28	30	34	42	52	38	40	42
"	4	21	29	51	52	66	33	19	63	81	26	45	44	37	62	55	45	35	50
"	6	*16*	*31*	60	*57*	81	*50*	*20*	80	78	*28*	74	83	56	53	45	64	*31*	69
"	8	47	69	48	74	69	70	70	67	*66*	61	68	81	*33*	47	*27*	*34*	80	52
"	10	53	51	*31*	81	52	88	89	*48*	96	85	63	71	95	*36*	65	63	87	47
"	12	51	89	78	105	*33*	102	72	88	99	90	*43*	*48*	107	81	84	72	84	*31*
"	14	47	61	90	82	89	76	54	105	96	65	98	101	83	95	73	80	62	101
"	16	44	*50*	86	*68*	100	*54*	*42*	104	82	*48*	110	108	*68*	88	72	70	*52*	108
"	18	*22*	83	76	107	84	127	101	92	*50*	117	99	106	131	*75*	*30*	*42*	112	91
"	20	71	92	*27*	123	72	104	120	*38*	97	110	*80*	*92*	124	99	105	82	117	*71*
"	22	70	75	87	85	*34*	78	84	120	83	92	107	100	89	89	106	91	111	91
"	24	68	65	79	77	81	*40*	*67*	100	93	*61*	93	90	*63*	94	*72*	81	86	102
"	26	45	46	62	38	78	103	93	66	67	71	81	87	14	66	16	69	*49*	81
"	28	33	*26*	56	*29*	76	95	109	*37*	*42*	78	63	84	96	32	78	*32*	89	73
"	30	24	70	42	89	61	83	96	86	66	85	46	68	90	8	70	74	86	57
June	1	*24*	70	*42*	88	60	*82*	96	86	66	84	46	*68*	90	8	70	74	86	56
"	3	54	70	73	49	24	69	55	47	39	40	27	63	36	*9*	30	45	89	28
"	5	58	33	37	29	14	64	34	28	27	22	14	74	18	94	20	30	60	16
"	7	50	21	24	20	11	41	20	18	18	16	*11*	59	11	83	18	20	*40*	*12*
"	9	44	18	19	24	*14*	42	26	26	*21*	15	85	57	11	28	*25*	24	105	156
"	11	35	23	25	*21*	97	36	*31*	*32*	145	*14*	18	36	*24*	..	97	25	113	73
"	13	*28*	*28*	*28*	110	57	43	105	145	85	123	10	30	119	..	45	*22*	98	43
"	15	78	127	119	73	23	*32*	60	57	16	21	7	*18*	67	..	10	58	*41*	10
"	17	64	34	70	14	4	97	..	11	8	6	..	78	29	..	1	32	82	..
"	19	60	14	36	..	..	54	..	..	2	4	..	76	..	..	..	..	68	..
"	21	53	..	..	..	..	28	..	..	..	..	..	53	..	..	..	..	72	..
"	23	31	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	65	..
Aver.....		33.9	57.	61.7	**66.8**	63.9	**65.7**	60.8	60.3	67.4	57.7	57.5	63.4	**72.1**	61.7	59.5	57.1	62.0	**63.9**
Av. from April 10		44.9	55.7	56.3	67.8	59.4	68.8	63.7	63.1	68.8	55.2	55.5	65.8	68.4	57.9	59.4	53.5	68.4	61.9

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ng leaves.—Beginning March 11.

SO_4			$Co(NO_3)_2$				$NiSO_4$				$ZnSO_4$				$Al_2(SO_4)_3$		Fe pow.				
B–5	B–6		B–7	B–8	B–9	B–10	B–11	B–12	B14	B–15	B–16	B–17	B–19	B–20	B–2	B–13	B–18				
M	M		M	M	M	M	M	M	M	M	M	M	M	M	M	M	.9 GM.				
10000	50000		1000	5000	10000	50000	100	1000	5000	1000	1000	1000	5000	10000	10	100					
37[4]	39[4]		46[4]	63[4]	61[4]	*32*[4]	24[4]	58[4]	51[4]	44[4]	50[4]	60[4]	38[4]	18[4]	..	34[3]	92[5]				
54	48		*16*	56	*41*	72	23	*43*	*40*	48	42	33	37	8	*9*[3]	17	88				
36	46		87	*29*	96	70	*10*	83	69	*44*	*44*	*2*	58	16	35	*11*	*70*				
13	*17*		*65*	77	88	*56*	66	91	86	70	82	82	*15*	*12*	34	24	116				
54	62		93	60	*35*	98	*52*	*48*	*50*	67	67	*45*	54	41	21	32	75				
34	52		91	*26*	133	56	96	112	97	56	*53*	110	*48*	38	14	39	*71*				
37	*15*		51	64	65	50	70	71	74	*19*	83	77	55	*15*	*3*	*12*	72				
82	77		*27*	77	*70*	*38*	*85*	*80*	*88*	82	99	*69*	73	54	51	66	109				
38	47		84	*29*	95	83	104	99	109	55	57	103	50	38	35	51	55				
88	34		68	84	84	77	99	94	100	42	28	90	26	26	32	34	54	Controls			
74	*20*		*42*	68	63	54	75	71	81	*25*	*15*	74	*15*	*16*	*19*	*19*	34				
61	61		79	53	*41*	*26*	*49*	*44*	*56*	63	71	*45*	63	73	91	65	66	A		B	
25	54		74	*27*	63	77	103	78	95	67	*45*	110	*41*	47	65	*57*	69				
72	*36*		49	54	61	64	88	66	81	*43*	73	87	65	*38*	*31*	88	58	C–3	C–4	C–2	C–5
91	77		54	85	70	69	91	75	95	76	97	*99*	84	72	112	117	60				
72	85		*27*	80	53	*49*	*66*	*62*	*64*	90	78	125	81	74	*104*	*100*	*44*	*39*[5]	*56*[6]	*17*[5]	75[7]
21	57		80	35	31	99	106	94	104	63	38	106	20	45	92	120	76	66	75	58	61
20	54		80	34	28	95	100	92	102	60	34	103	17	42	89	116	73	64	74	58	60
20	54		80	34	28	94	100	92	102	60	34	103	17	42	89	116	72	64	74	58	60
11	*37*		67	*21*	*19*	*76*	86	77	83	*40*	*21*	*75*	*8*	*25*	*65*	*78*	70	*42*	*57*	*32*	*32*
28	45		24	47	41	43	38	31	*27*	56	33	60	*24*	53	122	102	38	76	87	75	58
14	28		*12*	36	26	32	*22*	20	40	40	32	52	40	44	104	78	24	66	60	*54*	*34*
27	65		52	76	73	95	72	*56*	127	98	84	108	103	75	*101*	117	*68*	*72*	103	101	123
55	66		55	54	*52*	83	64	117	110	87	*48*	104	117	*47*	168	*58*	103	103	*58*	112	131
59	41		53	*21*	55	71	52	85	80	45	77	61	61	66	112	58	73	83	94	77	82
48	24		44	30	34	40	36	56	46	*22*	58	42	*38*	56	82	58	34	62	66	54	44
51	*15*		61	41	47	45	44	56	43	48	88	*31*	53	54	*54*	55	55	*42*	60	*31*	29
60	60		56	76	73	*39*	49	64	*38*	63	73	68	90	51	128	82	83	80	*58*	71	*22*
37	59		47	60	72	63	36	*37*	87	62	56	65	78	38	127	64	71	77	75	74	76
13	98		*34*	57	62	79	28	67	99	73	*38*	87	51	*30*	116	62	*37*	79	85	81	82
98	58		75	55	*46*	91	*13*	93	82	57	93	77	dead	54	93	*52*	95	*67*	92	*66*	73
86	39		84	*32*	82	63	86	81	63	37	101	49	..	56	*56*	96	92	95	66	88	*40*
72	*26*		80	44	84	*52*	84	72	*42*	*22*	92	*32*	..	58	106	98	80	94	*44*	86	60
113	79		77	52	96	95	61	*32*	124	90	69	86	..	60	111	94	72	78	71	67	49
101	83		*47*	59	82	107	*23*	91	107	80	*35*	88	..	48	109	75	*44*	80	119	77	86
82	70		100	43	60	95	74	84	92	67	97	73	..	*33*	82	38	87	*44*	77	53	78
62	51		96	42	*22*	78	76	74	*47*	*34*	79	*36*	..	55	60	*23*	85	92	*36*	*31*	*53*
39	*32*		89	63	55	*37*	51	39	75	75	48	79	..	63	*33*	86	77	102	98	74	80
99	71		61	65	80	77	28	*23*	80	58	34	51	..	61	85	88	65	70	89	94	93
84	72		36	60	72	80	22	64	70	48	34	34	..	52	78	74	48	44	74	80	88
84	72		*36*	*60*	72	80	*22*	64	70	48	*34*	34	..	52	78	74	*48*	*44*	*74*	80	*88*
29	26		51	58	27	36	28	28	34	20	67	14	..	*16*	53	*29*	60	113	102	*37*	86
12	12		43	31	14	15	13	26	25	14	9	12	..	55	16	76	35	62	62	78	29
7	10		26	28	10	10	9	*24*	*23*	*11*	4	*9*	..	55	11	68	24	45	38	69	38
11	13		22	51	*19*	13	*11*	126	180	74	1	19	..	62	7	66	24	28	30	73	37
131	*22*		35	68	123	*16*	80	85	63	53	..	39	..	42	8	49	26	27	28	42	32
87	63		31	86	79	36	45	32	34	40	..	30	..	28	*4*	38	*20*	*26*	29	26	33
30	17		*26*	65	15	44	6	3	14	10	..	1	..	14	32	24	114	111	*28*	19	*13*
1	2		58	37	..	3	5	..	1	4	..	..	..	*12*	19	9	27	15	61	*13*	44
..	..		28	22	..	..	..	..	..	..	..	..	..	58	14	*0*	6	00	32	60	44
..	..		14	28	..	..	..	..	..	..	..	..	..	..	14	14	6	..	19	25	24
..	..		..	27	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	3	..
52.9	46.6	55.4	50.4	58.3	**60.3**	54.5	65.8	**72.5**	52.1	55.9	**63.4**	50.0	44.7	**63.5**	60.8	61.7	....	....	....	....	
51.9	46.9	52.4	47.9	52.5	58.6	48.1	62.0	69.9	51.4	53.7	68.5	53.2	47.9	72.8	67.5	57.1	66.2	65.3	59.3	59.4	

March 13 to April 4 is only 63.3 mm, its average for the later part of its development is 67.8mm, and for the whole period 66.8 mm, the highest figure for any plant stimulated with borax. M|1,000,000 behaved like M|10,000, although showing no injury in the leaves. For this no plausible explanation can be offered except that, perhaps, some error was committed in applying the solution, or that this is the natural behaviour of the plant, the poison having absolutely no effect at that concentration. But at any rate, it appears sufficiently that a dilution of M|100,000 $Na_2Bo_4O_7$ is about proper for rice.

$MnSO_4$ in the concentration of M|1000 appears to have an accelerating effect upon the growth of rice, although the acceleration comes during the later part of its development. This behaviour is common to most of the concentrations found favorable in this experiment. Presumably, with these concentrations the amount of the stimulants that reaches the protoplasm of the growing part of the leaves and stems is not sufficient to affect them at the start, and only the later accumulation of the poisons brought about the desired effect. Solutions more diluted than M|1000 have no effect. The M|1000 solution of $MnSO_4$ equals 0.151 gram per kilogram of soil, which is about eight times the concentration given by Aso as favorable to the growth of radish, barley, wheat, and pea in water culture.

M|50,000 of $HgCl_2$ appears to exert some stimulating effect upon rice, as indicated in the averages. This is about four times as much as N|204,800, the limit of concentration of this same salt found by Heald for *Pisum sativum*, in water culture. Weaker solutions have no effect.

$FeSO_4$, produces a remarkable stimulating action at a concentration of M|1000. The plants treated with this chemical were very rich in color. The solutions weaker than M|1000 have no effect.

M|1000 $FeCl_3$ is deleterious. Plant A-1, stimulated with M|5000 solution, is of the same age as the other cultures, but it was transplanted March 10 to replace the one that was originally in the pot, which died March 9. For this reason the plant was much weaker than the rest at first. But a remarkable growth is seen in the later part of its development. This is undoubtedly the effect of the stimulant, which then at the concentration of M|5000 acts beneficially upon rice. M|10,000 also has a slight stimulating effect.

M|1000 $CuSO_4$ is injurious. This salt acts beneficially at a dilution of M|5000. M|10,000 still shows some effect, but the M|50,000 solution seems to have none. The plant stimulated with M|1000 showed a decided injury at the tips of its leave and the injury went so far as to affect the normal development of the fruits. The behaviour of the plant is very like that of the one treated with M|10,000 borax. In these cases the strength of the solution is enough to cause an immediate accelerating action upon the protoplasm of the growing part of the leaves and stems, but the later accumulation of the poison proves injurious. The concentration of copper found by Kahlenberg and True to be fatal in one day to lupines in water culture is N|25,600. The M|1000 solution used in this experiment, though injurious, was not fatal. It therefore appears that rice can stand in soil culture about twenty-five times as much concentration of $CuSO_4$ as lupines in water culture.

The results with $Co(NO_3)_2$ are not very instructive. While the average for any plant up to April 4 is greater than that of Mr. Zamora's number 1, the reverse is true in the table. It must be stated here that the average of the controls in the table is too high. This is indicated by the fact that with the exception of that of M|100 $Al_2(SO_4)_3$, the averages of the weakest cultures are lower than those of the controls. The late application of the fertilizers,

which acted then as stimulants, brought about this effect. The M|10,000 solution appears to have exerted some effect. Richards gives 0.002 *per cent* $CoSO_4$ as the optimum concentration for *Aspergillus niger*, in water culture. 0.002 *per cent* $CoSO_4$ is about 1/9 as strong as M|10,000 $Co(NO_3)_2$. Rice, then, can stand nine times as much concentration in soil culture as *Aspergillus* in water culture.

Better results were obtained with $NiSO_4$. M|100 proved stimulating at the start, but its injurious influence upon the later development of the plant is evident. It is clearly shown in the table that a concentration of M|5000 is about proper for rice. Richards found 0.033 *per cent* $NiSO_4$ as the optimum for *Aspergillus niger*. This concentration is about 1/9 as strong as M|5000. That is, rice can stand nine times as strong a solution in soil culture as *Aspergillus* in water culture.

$ZnSO_4$ is stimulating at a concentration of M|1000. Yet M|100 is not very injurious. It is to be noted that the plant growing in this solution fruited long before the others, but the development of the head was abnormal in that it did not come out fully, and the part remaining inside developed no grains. The plant treated with M|5000 was uprooted by the wind on May 11. The weakest solution had no effect.

Both plants treated with $Al_2(SO_4)_3$ were of the same age as the other cultures, but had been transplanted, and therefore, grew slowly at first. In their later growth they show a marked stimulating influence of $Al_2(SO_4)_3$. From the fact that this salt can be applied in so large a quantity with favorable results, it is evident that aluminium is not very poisonous, as, indeed, could be concluded from its universal occurrence.

The plant treated with 0.9 gram of iron powder shows a decidedly thrifty growth at the start, and it was for some time the most robust plant of the whole experiment. This beneficial effect is undoubtedly due to the slow but gradual solution of the iron, the concentration not reaching the point where it is fatal.

CONCLUSIONS

$Na_2Bo_4O_7$ at the concentration of M|100,000 exerts a favorable influence upon rice. The plant treated with M|100 solution was injured, but recovered sufficiently to bear fruits.

$MnSO_4$ acts favorably at a concentration of M|1000, which is about eight times the strength used with best effect by K. Aso on soy-beans, peas, wheat, and barley, in water culture.

M|50,000 $HgCl_2$ stimulates the growth of rice, and this concentration is about four times the limit of endurance given by Heald for *Pisum sativum*, in water culture.

$FeSO_4$ acts favorably at a dilution of M|1000.

$FeCl_3$ is deleterious at M|1000, but favorable to the growth of rice at M|5000.

A concentration of M|1000 of $CuSO_4$ is injurious to rice. One half this streng this about the optimum. This is about six times the concentration found fatal to Lupines by Kahlenberg and True, in water culture.

$Co(NO_3)_2$ appears to exert a stimulating influence at a concentration of M|10,000, which is about nine times the concentration in which $CoSO_4$ was used with favorable results on *Aspergillus niger* by Richards, in water culture.

$NiSO_4$ is stimulating at a concentration of M|5000. This is about nine times the optimum concentration found by Richards for *Aspergillus niger* in water culture.

$ZnSO_4$ accelerates growth at a concentration of M|1000.

$Al_2(SO_4)_3$ in large quantity favors the growth of rice.

Fe powder exerts some good effect upon rice.

It is presumed that the greater concentration found to accelerate the growth of rice as compared with subjects of previous investigation is not a characteristic of the rice plant, but rather the result of using soil instead of water culture.

I am indebted to Professor E. B. Copeland for help in planning the experiment, and in preparing this paper.

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THE EMPLOYMENT OF STUDENTS

As numerous letters are received by this College from prospective students inquiring as to the possibility of their securing employment so as to be able to pay a part for the whole of their expenses, the following general statement is made: The College has a labor fund which has, up to this time, proved to be sufficient for the employment of all students who desire to earn money by rendering service. It is, and will continue to be, its policy to give employment to students so far as they desire, in preference to hiring daily laborers. The regulations governing this employment are as follows:

"The College employs students as Assistants and Laborers.

Assistants (Student) are paid by the month, reduction being made for days of absence. They are appointed by the Dean. A high grade of scholarship is one consideration in the appointment, and failure to maintain it is ground for cancelling the appointment.

Student Labor is paid by the hour, the remuneration of unskilled labor being ten centavos an hour. Payment is made at the end of the month. The time card of each student laborer must have the endorsement of the faculty member under whom the work has been performed, or, in the case of students working around or in the buildings on janitor service, of the head janitor.

Students are here to study, and the performance of service for the College must not be permitted to lower the *grade* of scholarship. However, it may decrease by one the number of subjects of study. Subject to exception by the Dean, the number of hours of service which a student laborer may perform are as follows:—

Students taking three or four subjects, whose monthly grades show no conditions and a general average of at least eighty, 150 hours per month.

Students conditioned in not more than one subject, or without conditions but with a general average below eighty, 100 hours per month.

No student whose reports for the preceding month show more than one condition, or less than three subjects of study will be given employment."

Under these regulations, 38 students did field work during the month of July. The number of hours varied from 3 to 132, and in one special case, to 155. The records on scholarship called for at the end of July showed that of these 38 students, 40% did satisfactory work in all

their classes; 34% were conditioned in one class; 13%, in two classes, and 13%, in three classes. Of all the students taking course in Agriculture, excepting a few who entered very late, 52% did satisfactory work in all classes; 27% received one condition; 13%, two conditions; and 8%, three. It would appear from this report that the average scholarship of these students who were given field employment is considerably poorer than that of the student body as a whole.

As a matter of fact, however, the time devoted to labor is not the principal explanation of this condition. Of the students working in the field, only 14 had attended this College before this year, and of these 9 received no condition. It probably happens everywhere that the students of the first year show a poorer grade of scholarship than those who are more advanced, and the low scholarship of the students working in the field is largely or altogether due to the fact that they are new students.

It should not be understood from this statement that our more advanced students ceased to undertake to earn their expenses, or that students without means are especially likely to fall out of the College. Older students who show proper improvement and efficiency are promoted to places as assistants, or given employment as janitors, and this of course leaves a comparatively small proportion of them for the field work.

It is to be understood that the labor in question here is altogether aside from the labor required as a matter of education, for which no remuneration is given.

Current Literature

AGRICULTURE IN INDIA

The most important branch of The Imperial Department of Agriculture is the Agricultural Research Institute located at Pusa. It issues from time to time several publications in the form of reports and bulletins on the different lines of investigation. It also publishes a quarterly magazine, The Agricultural Review of India. The following is an extract from the numbers of this magazine corresponding to 1910.

Preserving Seed-Potatoes.

Farmers in India who store their own seed of potatoes encounter a great difficulty in the ravages of the potato moth (*Phthorimaea operculella or Lita solanella*). This is a small brown moth, which can be seen in hundreds flying about potato fields, and is abundant in houses in which potatoes are stored. The eggs are laid on the tuber, usually in an eye, or on the under surface of the leaf of the growing plant usually at the angle of two veins; in the plant the caterpillar becomes a miner, making a blotch mine in the leaf, or it bores in the shoots or leaf petioles, causing the shoot or leaf to wither; in the tuber the caterpillar tunnels in the potato entering at the eye, and the presence of the caterpillar is shown by the black excrement grains on the outside of the tuber. The full-fed caterpillar pupates in the tuber, or if on the plant, in any convenient shelter on the leaves, stems, or ground, in a light cocoon. The insect completes its life history in one month so that the increase in number is rapid. The number of eggs laid varies, as many as eighty six being laid in one case. This pest is supposed to have been imported from Italy and other Mediterranean countries where India formerly got its supply of seed-potatoes.

From the experiments undertaken at Pusa to test the different ways in which seed-potatoes could be stored absolutely out of reach of the pest, the following was found to give good results: The tubers are soaked in an emulsion of crude oil made by mixing thoroughly one pint of the oil with four gallons of water. They are then heaped up in layers on bamboo mats, putting sand between layers and covering the whole pile thoroughly with sand. The crude oil emulsion in the proportion used is not strong enough to prevent the germination of the seeds, which can be kept thus for a good length of time. During the time of storage, the seeds must be visited at regular intervals, and the rotten ones separated and thrown out. (Vol. V, part I.)

A New Insecticide.

Insecticides to be commercially available must be: (a) insoluble in water, or rain washes it off; (b) cheap; (c) stable and not apt to decompose into compounds that poison the leaf. The best stomach poison found in America and elsewhere is lead arsenate. But there are several objections to the use of this chemical in India. Its careless use may lead to cattle-poisoning; it decomposes in this country if kept in paste form, owing partly to the high temperatures, and in decomposing it forms soluble arsenic which poisons the plant at once; it is relatively expensive. Of other substances that were tested, lead chromate offered several advantages. It is easily made in paste form; it is yellow and can be easily seen on a sprayed plant; it is extremely insoluble; soluble chromates do not poison plants to the extent arsenic does, so even were it to decompose, it would not be injurious. This chemical is applied at the rate of 1 lb. in 32 gallons of water; at this strength it is entirely safe, poisons caterpillars, and acts as a powerful deterrent. It is prepared as follows: Lead acetate is dissolved in a spraying machine and to it added a solution of potassium bichromate; a dense yellow precipitate of insoluble lead chromate is formed. The figures are as follows: 66.2 grams of lead nitrate combine with 29.4 grams of potassium bichromate giving 64.6 grams of lead chromate. In practice 2 ounces of lead nitrate combine with one ounce of potassium bichromate giving two ounces of lead chromate.

In protecting plants from caterpillars and grasshoppers, two things must be considered: whether a caterpillar which feeds specially upon the plant to be protected, or a grasshopper or beettle the attack of which is not restricted to it. For the former an insecticide that will kill the pest must be applied, because it can feed on nothing but that plant; for the latter a deterrent is sufficient because the pest will leave the sprayed crop and go elsewhere. (Vol. V, Part II.)

A Promising Weed.

In the same number (II, Vol. V), D. Clouston gives a note on a promising weed, the *Melilotus alba*. This is a leguminous weed growing on rice plots, and promises to be a good fodder plant. It germinates early in November, grows to a height of about three feet and is relished both by horses and cattle. At the same time that it can be raised as a fodder, it will serve as green manure, being a leguminous plant. This plant is a biennial. When once established in a rice field, it sows itself and, therefore, requires no attention. The seed lies dormant in the soil till about the first of November, germinating about the time the paddy is being harvested. To get it established the seed should be sown among the standing rice towards the end of October at the rate of 20 lbs. per acre. When grown for fodder, it continues to yield a valuable supply of green fodder from January till March. It requires no irrigation if grown on rice lands which are fairly retentive of moisture.

FERTILITY OF STERILIZED SOILS.

T. W. Leather in a note cites the explanation offered by Messrs. Russell and Hutchinson, of the Rothamsted experiment station, for the increased fertility of a partially sterilized soil. This fact has been known for a long time, but no plausible explanation could be offered for it. The work of Russell and Hutchinson showed that heating the soil to 95°C or treating it with an antiseptic such as toluene results in (1) a much more rapid production of ammonia from the organic matter of the soil; (2) cessation of nitrification; (3) no marked change in the amount of humus in the soil; (4) the accelerated production of unstable nitrogenous compounds. It was also proved that an unsterilized soil contained some factor which limits the development of bacteria, which factor is eliminated by partial sterilization. Further investigation showed that such organisms as infusoria, amoebae, and ciliata, which are known to devour bacteria, are practically eliminated from sterilized soil. The explanation offered for the good effect of sterilizing a soil is this: soils contain a wide variety of organisms, which may be divided into (a) saprophytes, which effect the decomposition of organic matter and (b) phagocytes and other organisms which consume living bacteria. When a soil is partially sterilized by toluene or heat, the phagocytes are killed, but bacterial spores survive. On removing the toluene and adding water, these spores germinate, and the resulting organisms multiply with great rapidity, resulting in a largely increased production of ammonia. But at the same time it was ascertained that other organisms suffer seriously, especially the nitrogen fixing ones, and the nitrifying organisms are destroyed entirely. The net result of sterilizing the soil seems to increase the amount of ammonia, but to inhibit nitrogen fixation and nitrification. The plant which is subsequently grown in such sterilized soil then apparently depends on ammonia as its source of nitrogen.

PSOPHOCARPUS TETRAGONOLOBUS.

This plant is known as Pe-myit (bean-root) in Burma. *Calamismis* is the Philippine name for it. It is grown here as in India for its fruits—long, four-sided, curly-winged pods, which are cooked when tender and eaten like beans. In Burma and in Indo-China, the edible roots of this plant are prized, and extensive well-tended fields are annually placed under the crop in many parts of the provinces. The interesting fact in the culture of this crop in upper Burma is that the seed used to establish the crop is annually imported into that place from the Shan States, for it is believed by the Burmese that seed locally matured will not yield plants robust enough to produce a profitable amount of roots. The Shans, on the other hand, do not raise the plant as a root crop, for they believe that their soil, climate, slope, and other factors, all go against the production of good roots; they raise it only in garden culture for seed. In the Shan States this plant is a hardy perennial, which, when properly cared for, attains to a large size and bears seed in abundance. In Burma the seed is sown in August to September and the roots dug up in January. Part of their crop is consumed at home, and part is exported to the Shan States. "Low-lying fields with stiff clayey soils under moist and fairly cool atmospheres offer some of the more important natural conditions requisite for the successful cultivation of pe-myit, and ..... it is known to thrive best only when liberally manured with well-rotted cow-dung."

In regard to the cultivation of the crop the following is given: "At the commencement of the rains, the field is prepared by ploughing in, per acre, from 40 to 50 cart-loads of fine old cow-manure. In July

or August, it is cross-ploughed, harrowed, levelled, and the surface made up into long, narrow ridges with furrows between. The ridges as a rule are a foot and a half wide and six inches high, while the separating furrows are at least a foot wide. The ridges are stocked by sowing the seeds in holes made on them with the end of a stick. The holes, which are about an inch deep, are drilled in rows three inches apart. In some fields every three rows of the holes are separated from every other three rows by a space of about a foot in width, so that the holes are grouped in rows of three. Only one seed is usually sown to the hole; it is firmly pressed down by the hand of the sower. One bushel of seed stocks an acre of land. Unless it be showery weather or actually rainy at sowing time, the field, directly it shall have been stocked, is freely watered by flushing the drains. But when the beds have been wet, the surplus water, if any, is carefully drained off the seed beds and drains. In a week from sowing them the seeds germinate, when the field, if required, is watered again; it is thereafter kept in a moist condition by a judicious method of tedious watering until the pods get ripe and the roots are mature. Excessive moisture is said to be almost as fatal to the perfect success of the crop as the drying of the beds would be from the dearth of it." When sown in August the plant ordinarily flowers in November and fruits in December. The pods when young are cooked and eaten. "The dense-fleshed, spindle-shaped tuberous roots are scraped, packed in rice straw, and boiled in pots of water to which, as a rule, small quantities of til-seed oil have been added. The straw imparts a reddish colour to the roots, while the oil is said to loosen the skin and so help in their easy pealing when boiled. The boiled roots have a somewhat waxy consistence, a pronounced bean odour and a mild nutty taste." The crop is a very exhausting one. (Extract from *Capital*, June, 1910, and published as a note in Vol. V, Part IV.)

The Mango Weevil in Florida

(*Cryptorhynchus mangiferae, Tab.*)

The United States Department of Agriculture issued June 20th of this year a circular for the prevention of the spread of this enemy of mango in Florida. This is the most serious insect pest of the mango in Oriental countries. It is related to the boll weevil and chestnut weevil. It is of Oriental origin, probably Indian, and is being carried easily with seed for planting. The pest has gained foothold in mango regions on the Indian Ocean and adjacent islands, throughout the East Indies, including the Philippines and other groups of South Pacific Islands. It also occurs in South Africa, Madagascar and numerous other points.

The insect deposits its egg in the fleshy part of the fruit and the young grub that develops from it burrows at once into the seed pod and develops in the seed to a pupa, and finally to the adult weevil. The adult is about one-fourth of an inch long and dark brown in color. It remains in the pod for some time and may thus be easily distributed with seed for planting or with the ripened fruit.

As the insect is protected within the pod of the seed, it is not possible to destroy it by fumigation with any certainty. The only way of determining its presence is in opening the seed pod and removing the paper-like covering of the seed itself, when normally the gnawing and excrement and discoloration due to the work of the larvae and weevil can be noted.

The Department recomends the following method of prevention:

"All seeds introduced for planting in this country (U. S.) in regions where mangoes are grown should be opened in this manner and all that indicate infestation should be burned. As a matter of further

security all the apparently sound seeds should be germinated in a box under a wire screen, so that any weevils which may occur in seeds which show no visible sign of infestation may be retained and destroyed. The danger is particularly great where, as is now the case, mango seeds are being imported for planting in regions in Florida where fruiting mango trees occur. Where there are no mango trees, or trees of fruiting age, the danger is perhaps negligible, as no other food plant is known for the mango weevil. Still, if large numbers of these weevils should be introduced and liberated, they are long lived and might easily be carried on railway trains to regions where they might find lodgment. It is, therefore, desirable in any case to observe the above measures".

Sugar Cane in Porto Rico

Bulletin No. 9 of the Porto Rico Agricultural Experiment Station, published in 1910, has just been received here. Its subject is: "Sugar Cane in Porto Rico."

Besides considerable information as to the sugar industry of that Island, and reports on a large number of experiments with cane, it contains also in very compact form a summary of observations in many other countries. The export of sugar from Porto Rico amounts to eighteen million dollars a year, being more than two-thirds of the total export of the island. There are three varieties in most common use, known as Cristalina, Otaheite or White, and the Rayada or Striped. Besides these, there are found also varieties known as the Penang and Convangerie or French cane. The latter is conspicuously free from disease; it is said to have been introduced from Mauritius. Work with cane from seed is under way in Porto Rico, but the most successful experiments of this kind have so far been made on seedling cane imported from Barbados, Demerara, and Trinidad. It was found that in general cane grown from seed gave a larger gross yield, and was richer in sucrose and of higher purity than the common varieties propagated vegetatively. Similar results have been obtained with the same seedling verieties in all parts of the West Indies and in Louisiana. For instance, in Louisiana splendid results have been obtained with the seedling cane from Demerara known as No. 74. Compared with two of the native varieties, this cane yielded 5.68 tons more of cane per acre, and a sucrose content 1.8 per cent higher. Moreover it is more economical in harvesting, being an erect cane which stubbles freely, and it mills better than the native varieties. Calling the yellow clarified sugar worth four cents a pound, the crop or plant-cane and first year's ratoons gave an average increase of $39.70 per acre over the home canes.

The usual method of planting in Porto Rico is to use holes made with spades. An experiment in which this method was compared with planting in furrows give the following results in tons of cane per acre.

	Tons.
In holes	36.6
In furrows, seed on end, 2.5 feet apart	49.8
In furrows, horizontal in a continuous row	54.1

With regard to the distance in planting, experiments were made spacing the cane 10×10 feet, 7½×7½ feet, and 5×5 feet. In the large number of experiments it resulted in every case that the closer the planting, the greater was the yield, and that this is usually true of the ratoon crops as well as of the plant cane. A similar experiment at the Queensland Sugar Station showed that as between rows four feet apart and seven feet apart, the closer planting yielded 20 tons per acre more of cane, and 2⅓ tons more of sugar. In Cuba

two systems are in use. One is to plant in hills three feet apart with a distance of 4½ to 5 feet between the rows. The other, known as Zayas system, is to plant about 9×12 feet, and to practice continuous cultivation. Experiments at the Cuba Experiment Station have shown the Zayas system to be more costly and to give a smaller crop. It is worthy of note that the usual practice in the Philippines is to plant cane considerably closer together than was done in any of the experiments mentioned here. Experiments in Negros have shown that of the distances used there, the widest spacing gives the largest yields.

The experiments on fertilizers in Porto Rico have shown that the addition of nitrogen, phosphorus and potash, whether separately or together, resulted in an increased yield, and indicate that the greatest increase is to be obtained by the joint use of nitrogen and potash. These experiments, however, have not yet reached the stage where any general conclusions as to the profit from the use of artificial fertilizers can be drawn. Experiments with lime, however, have, almost without exception, shown such an increase in yield that its use is certainly profitable. The lime in most of these experiments was burned, but in one experiment soft coral limestone was used as found. Using plats 10×10 feet, one pat was treated with five gallons of burnt lime and yielded at the rate of 56.1 tons per acre of cane. Another plat was treated with the same amount of soft unburnt lime, and yielded 39.8 tons, while a check plat without lime yielded 24.9 tons. These plats can hardly be regarded as of sufficient size to give reliable results. The Hawaiian Sugar Planters' Station has found that the application of ground coral or gypsum resulted in an improvement in the amount of sucrose and the purity of the sap, and by the application of either of these, the increase in the yield of sugar has been found to reach about 47 per cent.

The practice of stripping old leaves from the cane has been coming steadily into favor since the American occupation of Porto Rico, and it is not unlikely that it is overdone. Hawaiian experiments have shown that this process is sometimes profitable, but by no means always so. For instance, in one experiment it was found that stripped cane yielded 60 tons per acre while check cane unstripped yielded 87 tons, and that in both plant-cane and ratoons, the unstripped cane showed the higher percentage of sucrose and coefficient of purity.

Records kept on a large scale at various Porto Rican mills have shown a loss in weight in shipping of from 5.8 to 8 per cent. Delay in grinding after the cane is cut results also in a decided deterioration in the quality of the juice. The Bulletin also contains observations on drainage, irrigation and plowing, but these are not in such shape that they would be of definite value in the Philippines. It also contains statements with regard to the extent and activity of the root systems of the plant which need to be substantiated by detailed observations before they can safely be accepted.